REMARKS/ARGUMENTS

In the office action, Examiner states that applicant is required to submit an amendment clarifying exactly which claims are in the case and exactly what form they are in. Per the Examiner's suggestion, Applicants have cancelled claims 31-46 and have added new claims 47-60. Applicants are canceling claims 31-46 and adding new claims 47-60 for clarification purposes of the prosecutorial history with the clear intention of not limiting the scope or breadth of this application by this action.

I. CLAIM REJECTION UNDER 35 USC § 103

In the Office Action, the Examiner had rejected claims 31-39 under 35 USC 103(a) as being unpatentable over Parker et al. in combination with Charms. Applicants' new claims 47-54 correspond to cancelled claims 31-39 and will be discussed in view of Examiners statements.

Parker et al teaches an x-ray microtube for the treatment of a patient with a tumor. In column 9, lines 44-47, Parker et al discloses that an x-ray microtube of this design can be made within a range of 1/8" to 1", and preferably 1/4". In column 10, lines 25-30, Parker et al discloses filament lines for coupling to the anode and the cathode. Also disclosed are coolant hoses routed in the microtube for cooling that is required reliable operation. In column 9, lines 21-22, Parker et al discloses a wire filament electrode used to generate electrodes.

Applicants describe an apparatus for delivering localized x-rays in a micro-environment such as an artery. An artery has a diameter smaller than the minimum dimension for the x-ray microtube described in Parker et al. For example, a coronary artery after dilation by angioplasty has a diameter of only 3 millimeters or less. The apparatus must have a diameter smaller than 3

millimeters for effective placement in the region requiring x-rays. Applicants claimed invention is capable of being formed to the dimensions 3 millimeters or less and addresses the issues involved with making a complex x-ray device this small.

The reduced dimensions of the x-ray apparatus greatly increase the problem of electrical flashover. Flashover occurs due to the high electric fields that are generated. For example, an electric field exists at the surface of the cathode while the outside of the vacuum housing is at a ground potential. An electrical discharge to ground is known as flashover and is detrimental to the operation of the x-ray apparatus. Applicants claimed invention reduces flashover at these small dimensions. Applicants' claim 47 includes an x-ray source, a vacuum chamber, an electrically insulating material, a flexible coaxial cable, and a conductive layer. Conversely, Parker et al. operates at much higher voltages than Applicants invention to generate x-rays. Operating at higher voltages requires liquid cooling as disclosed in Parker et al. because of the heat generated. Reducing the dimensions of Parker et al further would only increase the operating temperature of the device. The higher operating voltages also increase the probability of flashover and could have been a major factor on the stated minimum dimension. Thus, Parker et al is not adaptable for use having a diameter of less than 3 millimeters without substantial modification.

The combination of the electrically insulating material, the coaxial cable, and the conductive layer reduce problems associated with flashover when the diameter is 3mm or less. Moreover, the combination produces a highly manufacturable x-ray apparatus. The x-ray source which includes portions of the anode and the cathode are housed within a vacuum chamber. As claimed, an electrically insulating material is positioned between the vacuum chamber wall and the anode joints of the chamber wall. The electrically insulating material is

effective in reducing flashover as the diameter of the x-ray apparatus is reduced to 3 millimeters or less. The flexible coaxial cable has a center conductor and an external conductor. The center conductor couples to the anode of the apparatus. The center location of the conductor within the coaxial cable aligns to the anode connection greatly simplifying the connection. Similarly, the external conductor of the coaxial cable surrounds the center conductor but is electrically separated from one another by a layer of dielectric material. The location of the external conductor is positioned for coupling to the cathode. As claimed, the coupling is achieved by a conductive layer overlying a portion of the vacuum chamber coupling to the cathode and the external conductor of the coaxial cable. The conductive layer has a low profile, large conductive surface, and simplifies contact in a small confined area.

Parker et al in view of Charms, individually or in combination does not teach or suggest the combination of components claimed in Applicants claim 47 in forming an x-ray apparatus having a diameter less than 3 millimeters. Parker et al does not teach or suggest using a coaxial cable. Charms discloses a coaxial cable for use in carrying electrical energy to a heart for defibrillation. Applicant's use of the coaxial cable in contacting the anode and cathode allows for high voltages to be provided in a low profile. Parker et al. in view of Charms does not teach or suggest an electrically insulating material positioned between the vacuum chamber wall and the anode at joints of the vacuum chamber wall. Finally, Parker et al. in view of Charms does not teach or suggest the conductive layer overlying a portion of the vacuum chamber. Applicants respectfully submit that Applicants claimed invention is nonobvious in view of the fact that elements of the claimed invention are neither disclosed or suggested in the cited prior art.

As previously mentioned, Parker et al clearly states the minimum size that can be achieved with the disclosed design which is larger than applicants claimed largest diameter of 3 millimeters. There are many reasons why the design of Parker et al cannot be reduced in diameter beyond their stated minimum. Nor can it be modified to achieve smaller dimensions without extensive changes to all elements. Parker et al also teaches using individual wires to couple elements which is problematic in manufacturing at very small dimensions. The filament electrode disclosed requires higher voltage to generate x-rays and also generates significant heat. The higher voltage required by the filament electrode of Parker et al would greatly increase flashover if the dimensions are reduced. Thus, Applicants respectfully submit that independent claim 47 and dependent claims 48-54 are novel and allowable in view of the cited prior art.

In the Office Action Examiner had rejected claims 41-46 under 35USC 103(a) as being unpatentable over Parker et al in combination with Charms as applied to claims 31-39 and further in view of Suzuki and Houston. Applicants' new claims 55-60 correspond to cancelled claims 41-46 and will be discussed in view of Examiners statements. Examiner states that Suzuki and Houston teaches boron nitride as a housing composition in an X-ray tube. Houston teaches the equivalent of quartz and boron nitride as insulators.

Applicants' claim 55 includes a housing approximately 3 millimeters in diameter or less. As described in detail hereinabove, the housing of an x-ray device of this dimension or smaller is required for use in an artery. The arguments pertaining to the fact that Parker et al neither teaches or suggests dimensions of this size nor is the x-ray microtube disclosed in Parker et al adaptable to this dimension are relevant to claim 55 and applied hereto. Furthermore, Applicants claim 55 recites a cathode and an anode operating with an electric field of 20

keV/micron or less to prevent flashover. Operating at 20 keV/micron or less as claimed by Applicants prevents flashover at a diameter of 3 millimeters or less. Reducing the operating potential is not the only problem that needs to be resolved. The effectiveness of the x-ray apparatus is compromised unless the radiation generated is of sufficient magnitude for the medical purpose. Applicants disclose a x-ray device that operates under 20 keV/micron electric fields yet is capable of providing 8-10 keV of radiation which is useful for medical applications in an artery. The x-ray device uses a diamond film cathode that loses electrons easily at low field strengths. Parker et al uses a conventional filament cathode. The conventional filament cathode must operate at voltages higher than 20 keV to produce a useful radiation magnitude even in the 8-10 keV range. Operating at a higher voltage magnitude than 20 keV increases flashover and heat that cannot be easily dissipated in the small enclosure. Thus, Applicants respectfully submit that Parker et al is not relevant for these reduced dimensions. Moreover, the cited prior art of Charms, Houston, and Suzuki neither teaches or suggests how to produce useful x-ray radiation with input voltages less than 20 keV. Thus, Applicants respectfully submit that independent claim 55 and dependent claims 56-60 are novel and allowable in view of the cited prior art.

In view of Applicant's amendments and remarks, it is respectfully submitted that Examiner's rejections under 35 USC § 103, have been overcome. Accordingly, Applicants respectfully submit that the application, as amended, is now in condition for allowance, and such allowance is therefore earnestly requested. Should the Examiner have any questions or wish to further discuss this application, Applicants request that the Examiner contact the Applicants attorneys at 480 385-5060.

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Amdt. Dated Sep. 30, 2003
Reply to Office action of Apr. 1, 2003

If for some reason Applicants have not requested a sufficient extension and/or have not paid a sufficient fee for this response and/or for the extension necessary to prevent abandonment on this application, please consider this as a request for an extension for the required time period and/or authorization to charge Deposit Account No. 50-2090 for any fee which may be due.

Respectfully submitted,

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